US009154734B2

(12) **United States Patent**
Jang et al.

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(45) **Date of Patent: Oct. 6, 2015**

(54) **MULTIPLE SUBSCRIBER VIDEOCONFERENCING SYSTEM**

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(73) Assignee: **Margalla Communications, Inc.**, Woodside, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 118 days.

(21) Appl. No.: **13/865,190**

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Related U.S. Application Data

(63) Continuation of application No. 11/236,121, filed on Sep. 26, 2005, now Pat. No. 8,665,759, which is a continuation of application No. 09/819,548, filed on Mar. 26, 2001, now Pat. No. 6,980,526.

(60) Provisional application No. 60/191,819, filed on Mar. 24, 2000.

(51) **Int. Cl.**

H04L 12/16 (2006.01)
H04N 7/15 (2006.01)

(Continued)

(52) **U.S. Cl.**

CPC ***H04N 7/15*** (2013.01); ***H04L 12/1813*** (2013.01); ***H04L 29/06*** (2013.01); ***H04L 29/12009*** (2013.01); ***H04L 29/1233*** (2013.01); ***H04L 29/12047*** (2013.01); ***H04L 61/15*** (2013.01); ***H04L 61/25*** (2013.01); ***H04L 61/2503*** (2013.01); ***H04L 63/0272*** (2013.01); ***H04L 63/0428*** (2013.01); ***H04L 65/1006*** (2013.01); ***H04L 65/403*** (2013.01); ***H04L 65/4038*** (2013.01); ***H04Q 11/04*** (2013.01);

(Continued)

(58) **Field of Classification Search**

CPC H04L 12/1813; H04L 29/06027; H04L 65/1006; H04L 65/1009; H04L 12/1818; H04L 12/1822; H04L 12/1827

See application file for complete search history.

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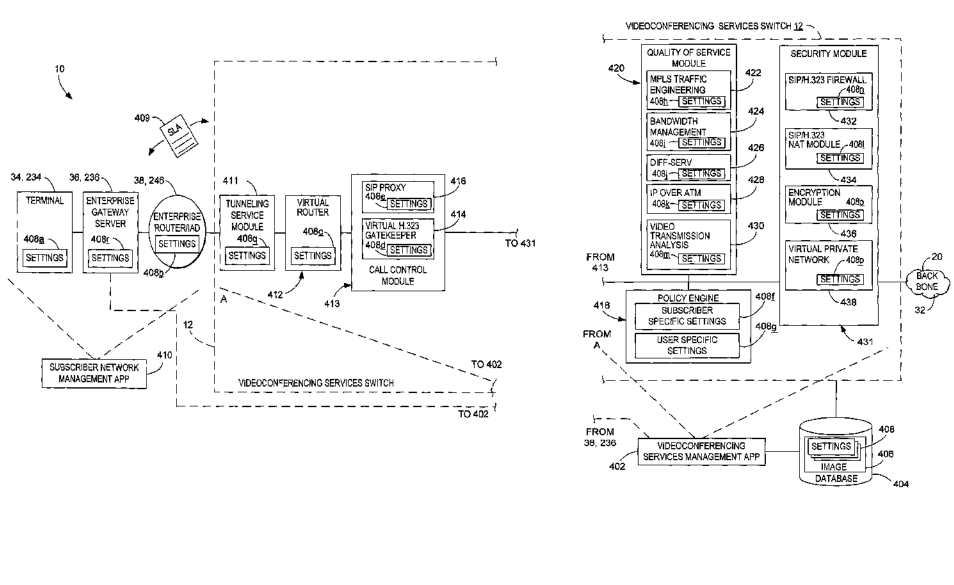
Primary Examiner — Phirin Sam

(74) *Attorney, Agent, or Firm* — Fogarty, L.L.C.

(57) **ABSTRACT**

A system, method, and device for use in videoconferencing. The method typically includes installing a videoconferencing services switch at an access point to an IP network, and registering a plurality of subscribers for videoconferencing services. Each subscriber typically has a plurality of endpoints. The method further includes receiving subscriber-specific settings to be applied to multiple videoconferencing calls from the plurality of endpoints associated with each subscriber. The method further includes storing the subscriber-specific settings at a location accessible to the switch, and configuring the switch to connect calls from the plurality of endpoints at each subscriber based on the corresponding subscriber-specific settings.

30 Claims, 10 Drawing Sheets



(51) **Int. Cl.**

H04L 12/18	(2006.01)
H04L 29/06	(2006.01)
H04L 29/12	(2006.01)
H04Q 11/04	(2006.01)

(52) **U.S. Cl.**

CPC *H04L29/06027* (2013.01); *H04L 63/0281* (2013.01); *H04L 63/164* (2013.01); *H04Q 2213/1329* (2013.01); *H04Q 2213/13034* (2013.01); *H04Q 2213/13103* (2013.01); *H04Q 2213/13106* (2013.01); *H04Q 2213/13109* (2013.01); *H04Q 2213/13166* (2013.01); *H04Q 2213/13196* (2013.01); *H04Q 2213/13204* (2013.01); *H04Q 2213/13335* (2013.01); *H04Q 2213/13337* (2013.01); *H04Q 2213/13339* (2013.01); *H04Q 2213/13348* (2013.01); *H04Q 2213/13389* (2013.01); *H04Q 2213/13399* (2013.01)

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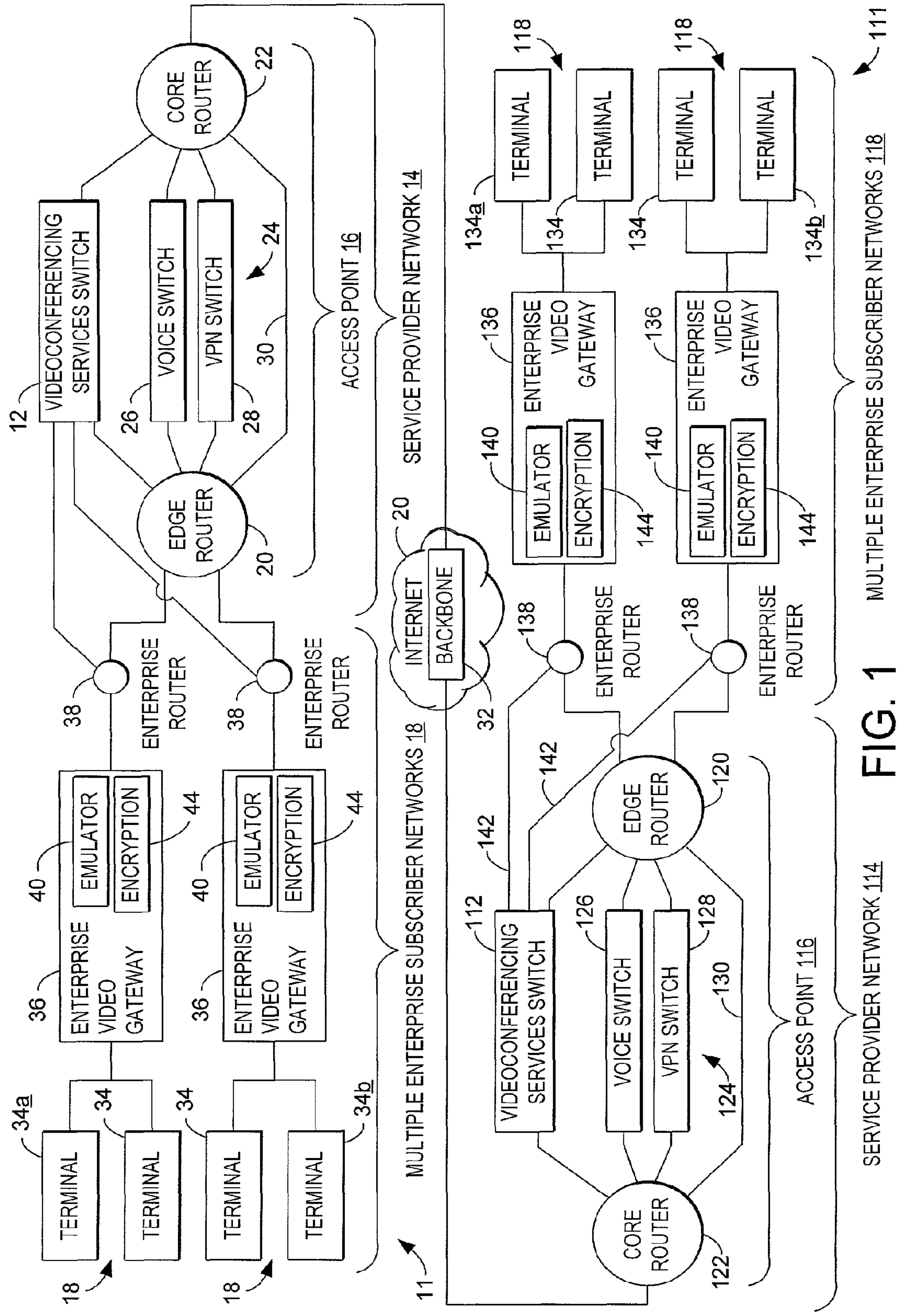

CORE ROUTER
22
VIDEOCONFERENCING SERVICES SWITCH
12
VOICE SWITCH
26
VPN SWITCH
28
24
30
EDGE ROUTER
20
ACCESS POINT 16
SERVICE PROVIDER NETWORK 14
ENTERPRISE ROUTER
38
ENTERPRISE VIDEO GATEWAY
36
EMULATOR
40
ENCRYPTION
44
TERMINAL
34
34a
34b
18
MULTIPLE ENTERPRISE SUBSCRIBER NETWORKS 18
11
INTERNET
BACKBONE
32
TERMINAL
134
134a
134b
118
ENTERPRISE VIDEO GATEWAY
136
EMULATOR
140
ENCRYPTION
144
ENTERPRISE ROUTER
138
MULTIPLE ENTERPRISE SUBSCRIBER NETWORKS 118
111
142
EDGE ROUTER
120
VIDEOCONFERENCING SERVICES SWITCH
112
VOICE SWITCH
126
VPN SWITCH
128
130
124
ACCESS POINT 116
CORE ROUTER
122
SERVICE PROVIDER NETWORK 114

FIG. 1

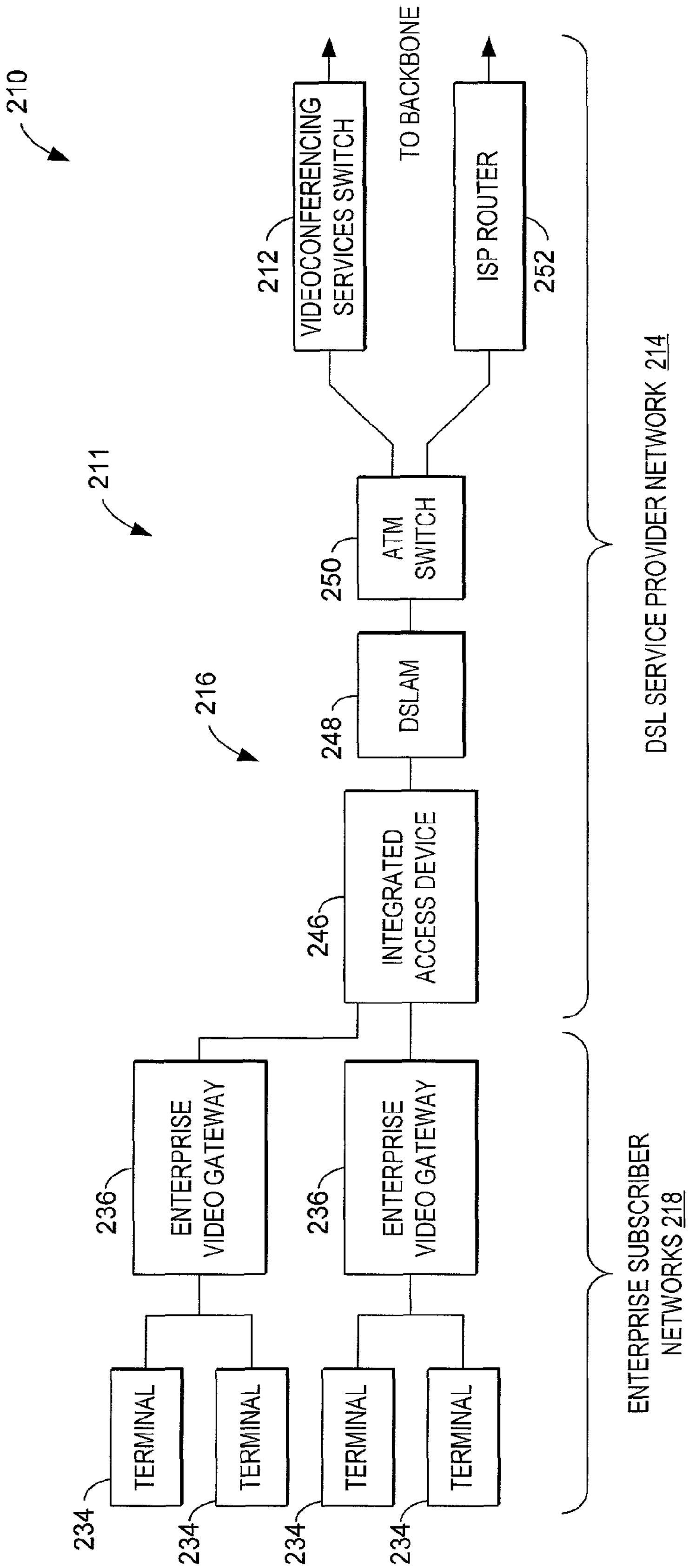

210
211
216
VIDEOCONFERENCING SERVICES SWITCH
212
TO BACKBONE
ISP ROUTER
252
ATM SWITCH
250
DSLAM
248
INTEGRATED ACCESS DEVICE
246
ENTERPRISE VIDEO GATEWAY
236
ENTERPRISE VIDEO GATEWAY
236
TERMINAL
234
TERMINAL
234
TERMINAL
234
TERMINAL
234
DSL SERVICE PROVIDER NETWORK 214
ENTERPRISE SUBSCRIBER NETWORKS 218

FIG. 2

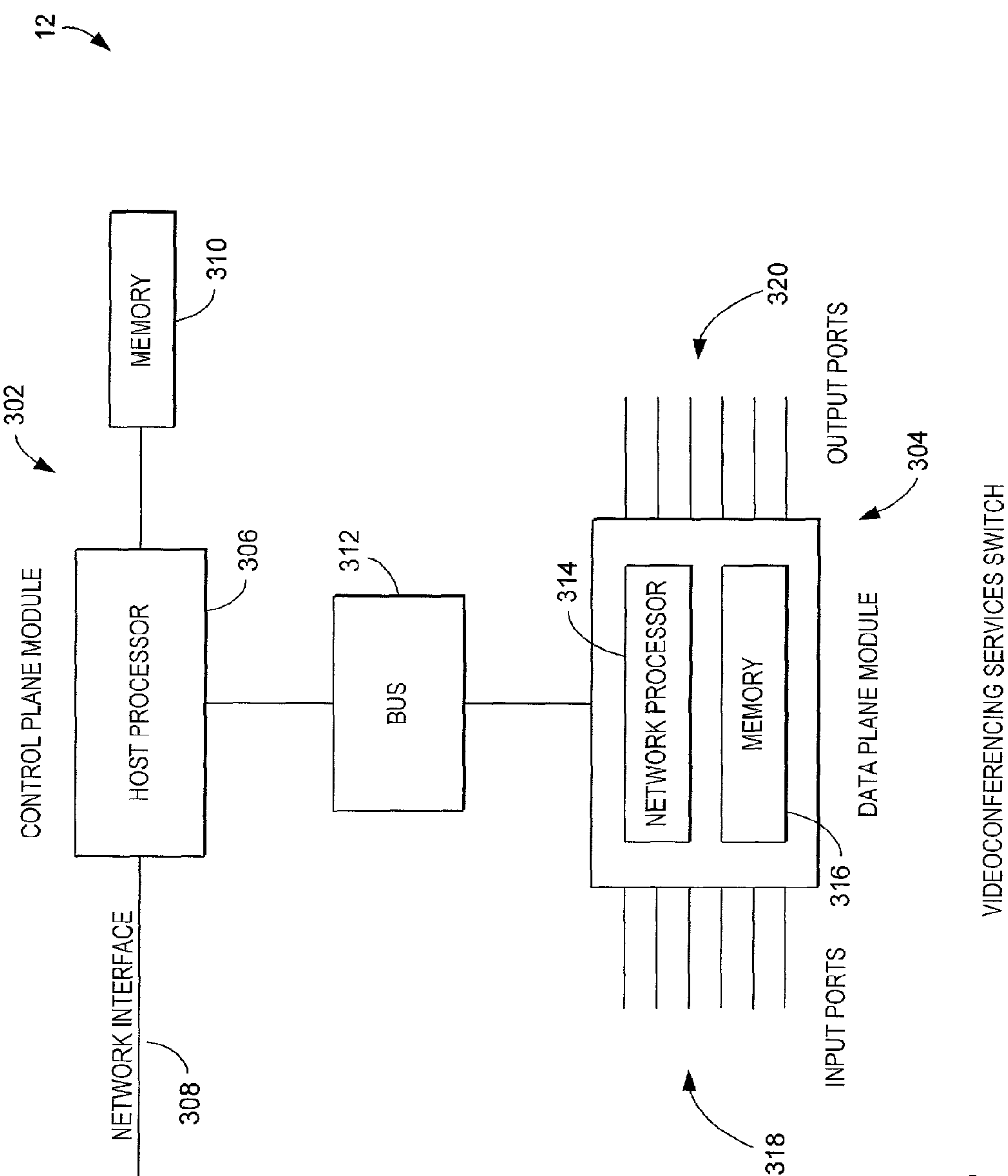
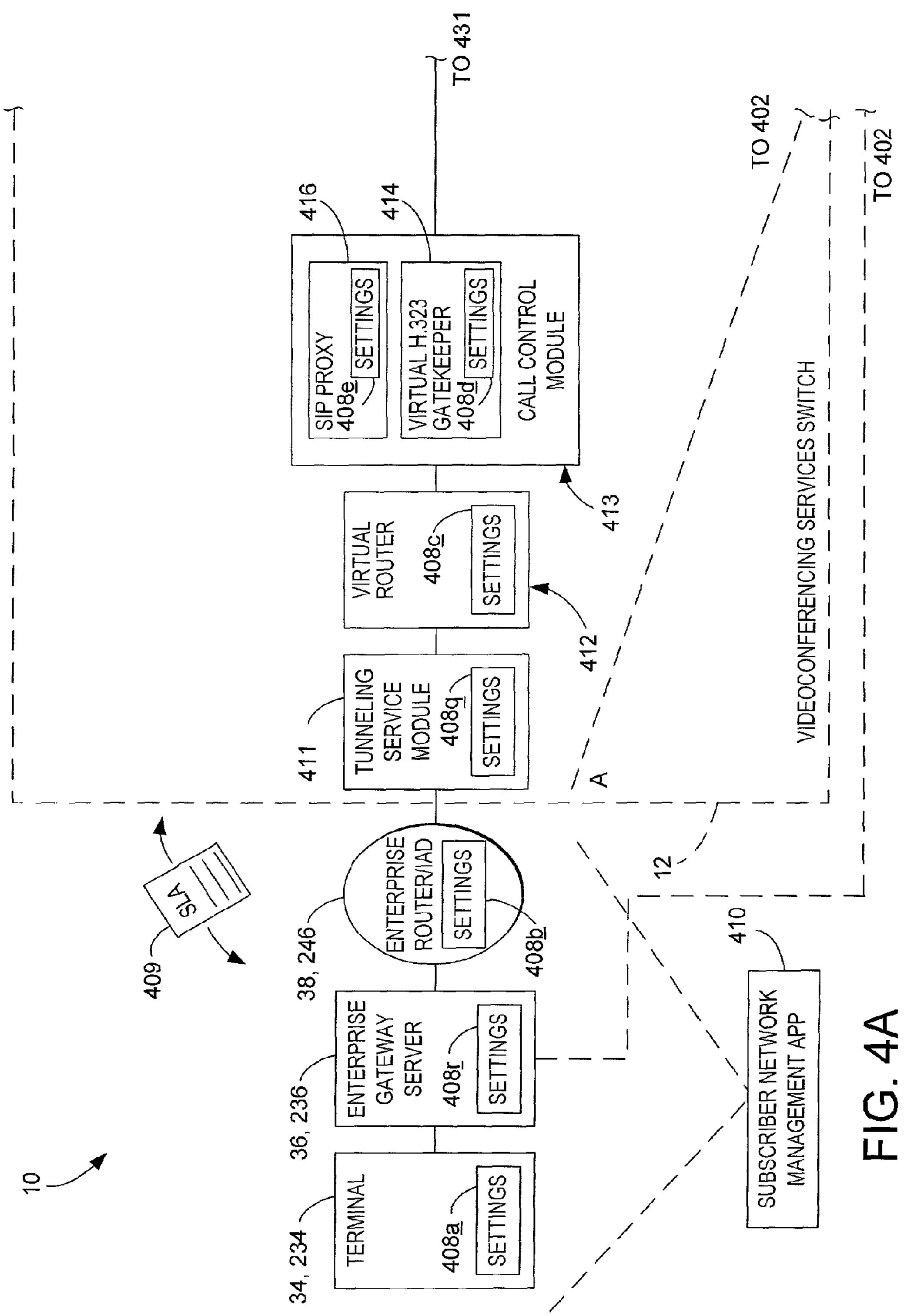

12
302
CONTROL PLANE MODULE
HOST PROCESSOR
306
MEMORY
310
NETWORK INTERFACE
308
BUS
312
NETWORK PROCESSOR
314
MEMORY
316
DATA PLANE MODULE
304
OUTPUT PORTS
320
INPUT PORTS
318
VIDEOCONFERENCING SERVICES SWITCH

FIG. 3



10
TERMINAL
34, 234
408a
SETTINGS
ENTERPRISE GATEWAY SERVER
36, 236
408r
SETTINGS
ENTERPRISE ROUTER/IAD
38, 246
SETTINGS
408b
SLA
409
TUNNELING SERVICE MODULE
411
408q
SETTINGS
VIRTUAL ROUTER
408c
SETTINGS
412
SIP PROXY
408e
SETTINGS
416
VIRTUAL H.323 GATEKEEPER
408d
SETTINGS
414
CALL CONTROL MODULE
413
TO 431
TO 402
TO 402
A
12
VIDEOCONFERENCING SERVICES SWITCH
410
SUBSCRIBER NETWORK MANAGEMENT APP

FIG. 4A

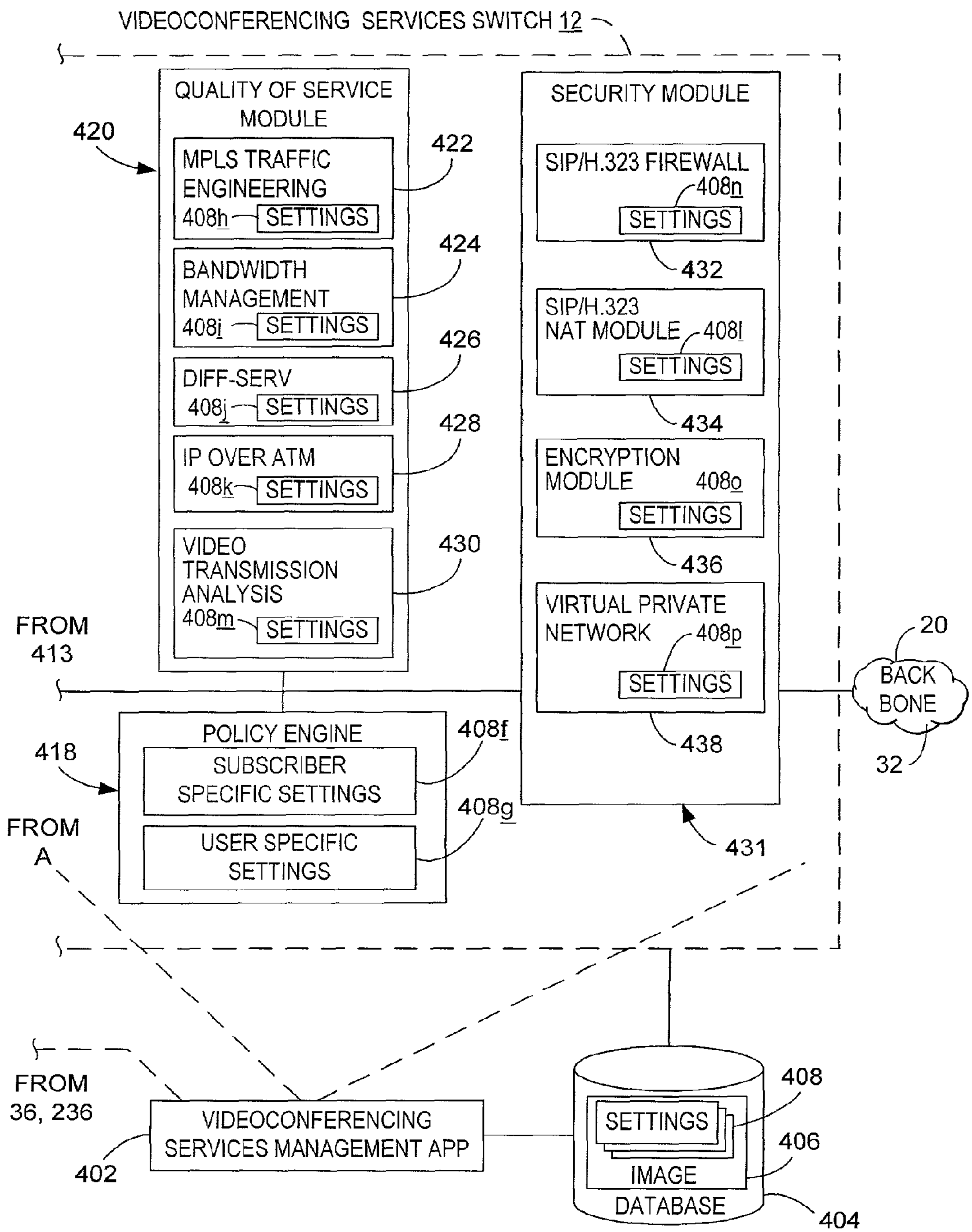

VIDEOCONFERENCING SERVICES SWITCH 12
QUALITY OF SERVICE MODULE
420
MPLS TRAFFIC ENGINEERING
408h
SETTINGS
422
BANDWIDTH MANAGEMENT
408i
SETTINGS
424
DIFF-SERV
408j
SETTINGS
426
IP OVER ATM
408k
SETTINGS
428
VIDEO TRANSMISSION ANALYSIS
408m
SETTINGS
430
SECURITY MODULE
SIP/H.323 FIREWALL
408n
SETTINGS
432
SIP/H.323 NAT MODULE
408l
SETTINGS
434
ENCRYPTION MODULE
408o
SETTINGS
436
VIRTUAL PRIVATE NETWORK
408p
SETTINGS
438
431
FROM 413
20
BACK BONE
32
POLICY ENGINE
418
SUBSCRIBER SPECIFIC SETTINGS
408f
USER SPECIFIC SETTINGS
408g
FROM A
FROM 36, 236
VIDEOCONFERENCING SERVICES MANAGEMENT APP
402
SETTINGS
408
IMAGE
406
DATABASE
404

FIG. 4B

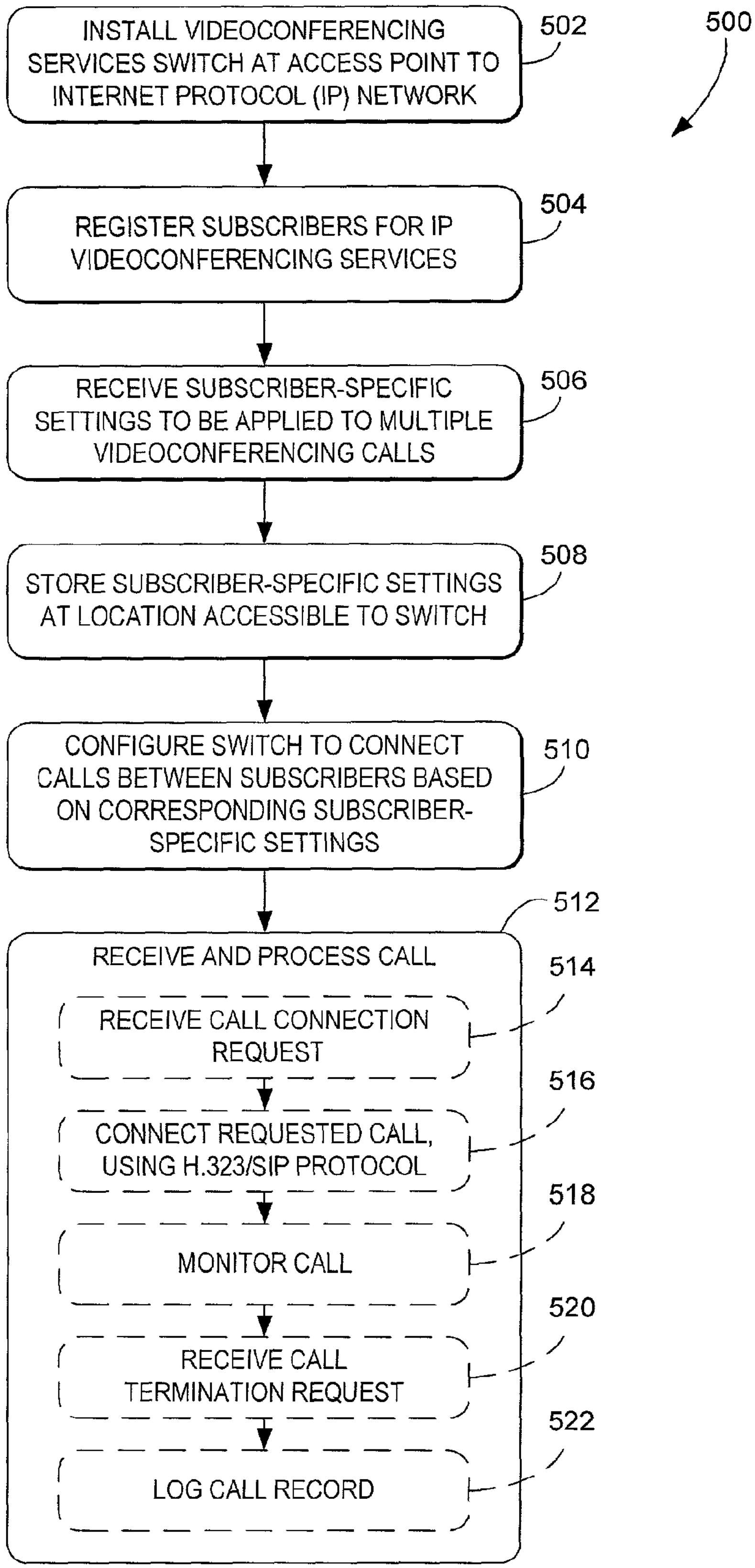

500
INSTALL VIDEOCONFERENCING SERVICES SWITCH AT ACCESS POINT TO INTERNET PROTOCOL (IP) NETWORK
502
REGISTER SUBSCRIBERS FOR IP VIDEOCONFERENCING SERVICES
504
RECEIVE SUBSCRIBER-SPECIFIC SETTINGS TO BE APPLIED TO MULTIPLE VIDEOCONFERENCING CALLS
506
STORE SUBSCRIBER-SPECIFIC SETTINGS AT LOCATION ACCESSIBLE TO SWITCH
508
CONFIGURE SWITCH TO CONNECT CALLS BETWEEN SUBSCRIBERS BASED ON CORRESPONDING SUBSCRIBER-SPECIFIC SETTINGS
510
512
RECEIVE AND PROCESS CALL
514
RECEIVE CALL CONNECTION REQUEST
516
CONNECT REQUESTED CALL, USING H.323/SIP PROTOCOL
518
MONITOR CALL
520
RECEIVE CALL TERMINATION REQUEST
522
LOG CALL RECORD

FIG. 5

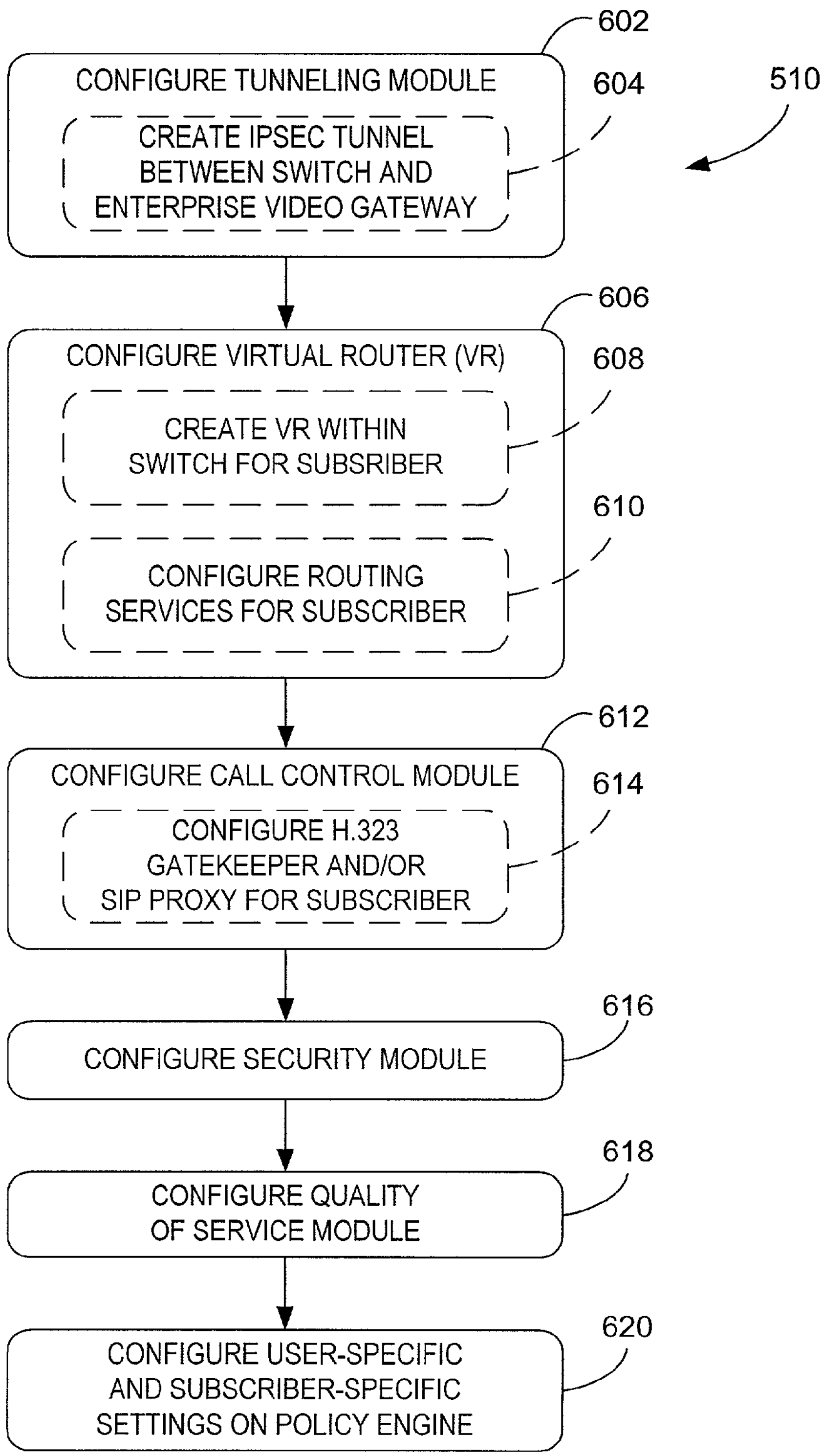

510
602
CONFIGURE TUNNELING MODULE
604
CREATE IPSEC TUNNEL BETWEEN SWITCH AND ENTERPRISE VIDEO GATEWAY
606
CONFIGURE VIRTUAL ROUTER (VR)
608
CREATE VR WITHIN SWITCH FOR SUBSRIBER
610
CONFIGURE ROUTING SERVICES FOR SUBSCRIBER
612
CONFIGURE CALL CONTROL MODULE
614
CONFIGURE H.323 GATEKEEPER AND/OR SIP PROXY FOR SUBSCRIBER
616
CONFIGURE SECURITY MODULE
618
CONFIGURE QUALITY OF SERVICE MODULE
620
CONFIGURE USER-SPECIFIC AND SUBSCRIBER-SPECIFIC SETTINGS ON POLICY ENGINE

FIG. 6

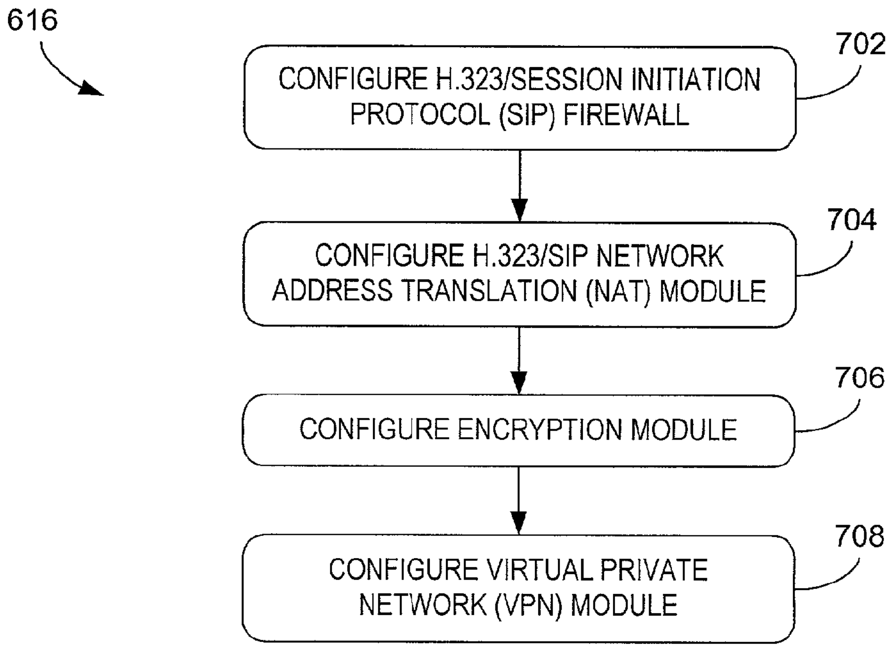

616
CONFIGURE H.323/SESSION INITIATION PROTOCOL (SIP) FIREWALL
702
CONFIGURE H.323/SIP NETWORK ADDRESS TRANSLATION (NAT) MODULE
704
CONFIGURE ENCRYPTION MODULE
706
CONFIGURE VIRTUAL PRIVATE NETWORK (VPN) MODULE
708

FIG. 7

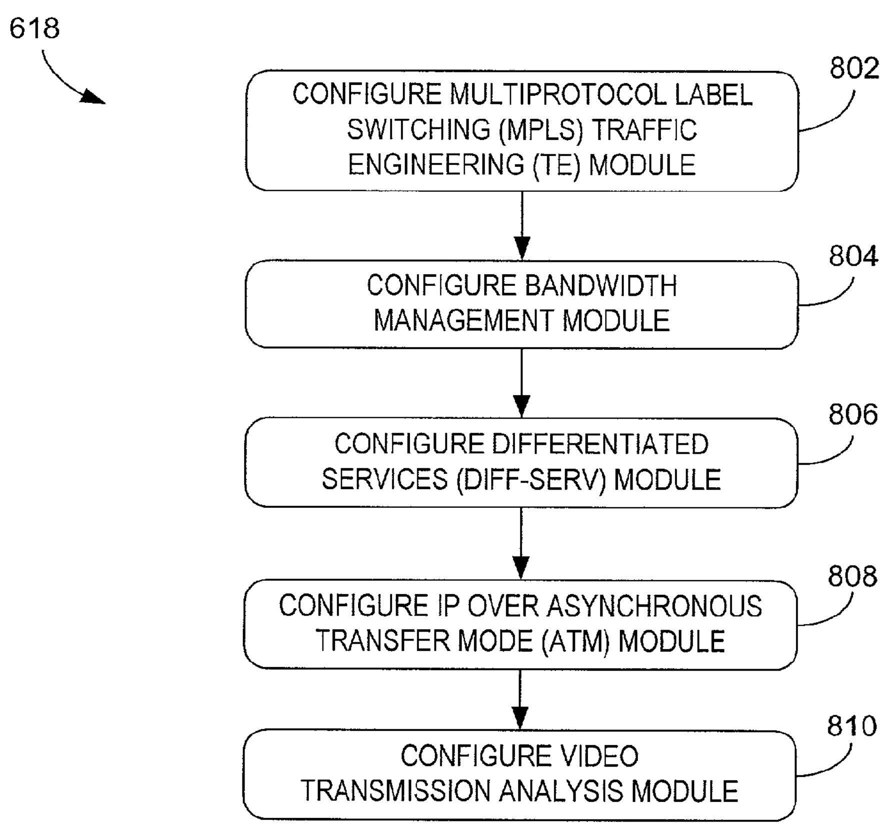

618
CONFIGURE MULTIPROTOCOL LABEL SWITCHING (MPLS) TRAFFIC ENGINEERING (TE) MODULE
802
CONFIGURE BANDWIDTH MANAGEMENT MODULE
804
CONFIGURE DIFFERENTIATED SERVICES (DIFF-SERV) MODULE
806
CONFIGURE IP OVER ASYNCHRONOUS TRANSFER MODE (ATM) MODULE
808
CONFIGURE VIDEO TRANSMISSION ANALYSIS MODULE
810

FIG. 8

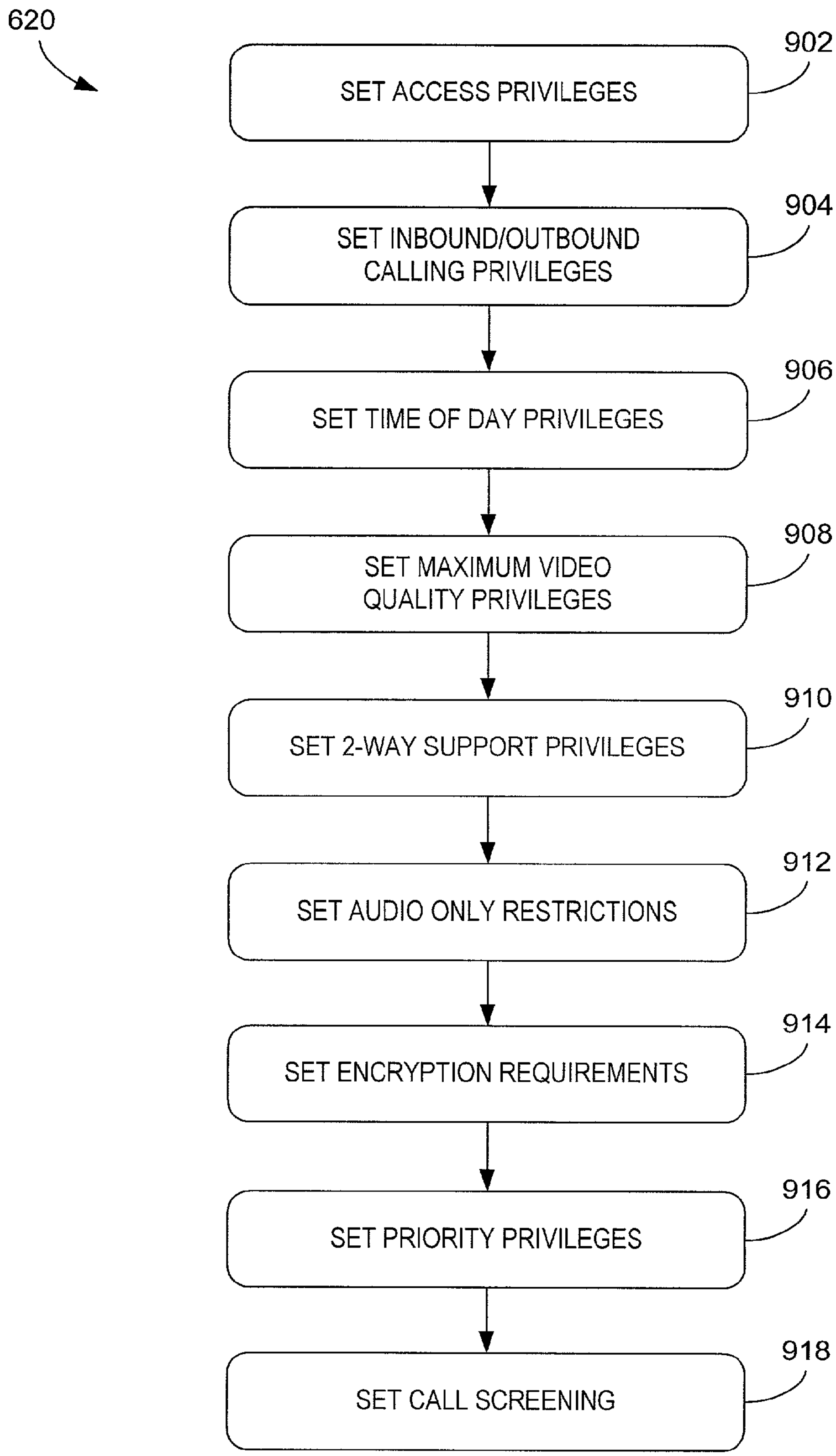

620
SET ACCESS PRIVILEGES
902
SET INBOUND/OUTBOUND CALLING PRIVILEGES
904
SET TIME OF DAY PRIVILEGES
906
SET MAXIMUM VIDEO QUALITY PRIVILEGES
908
SET 2-WAY SUPPORT PRIVILEGES
910
SET AUDIO ONLY RESTRICTIONS
912
SET ENCRYPTION REQUIREMENTS
914
SET PRIORITY PRIVILEGES
916
SET CALL SCREENING
918

FIG. 9

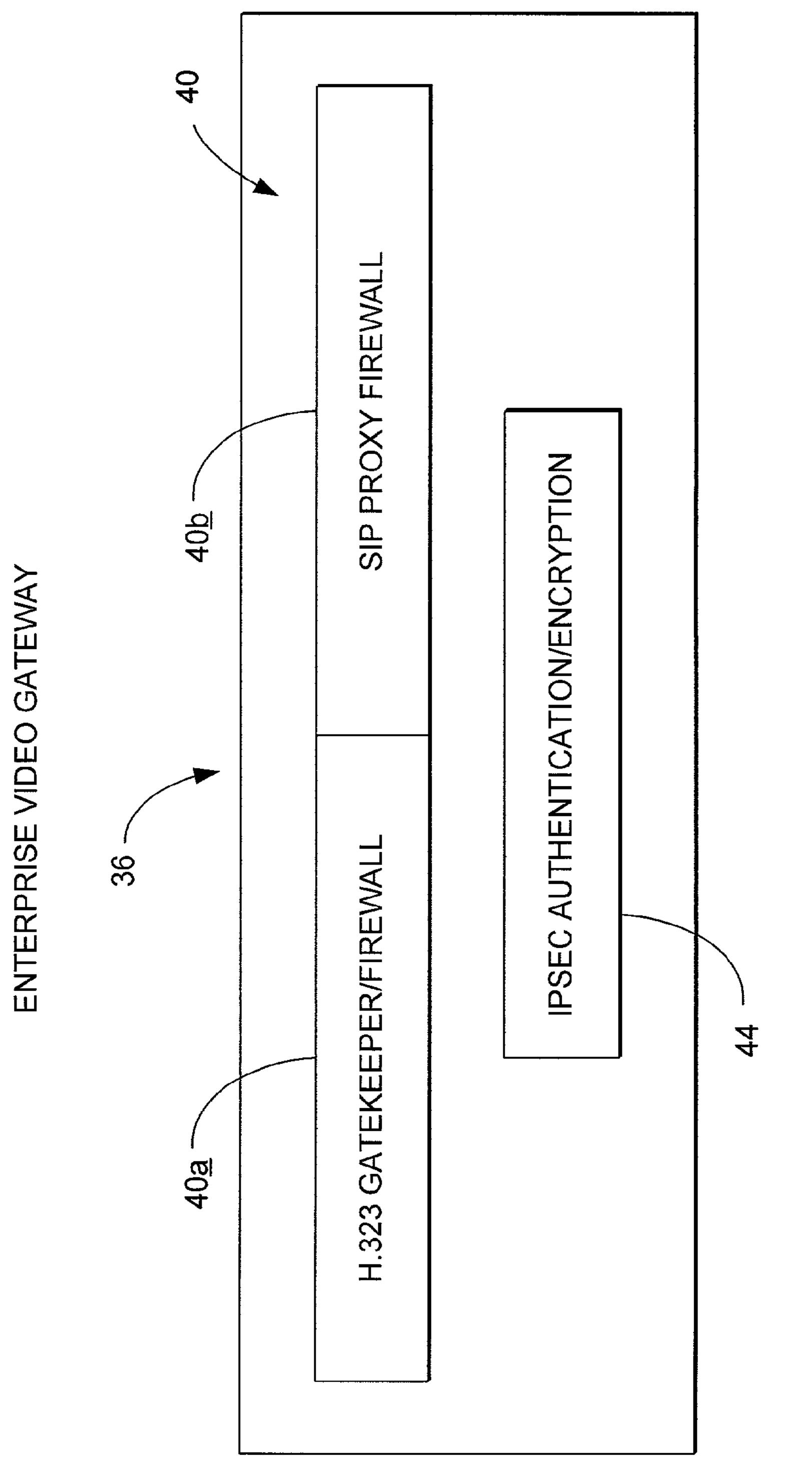

ENTERPRISE VIDEO GATEWAY
36
40
40b
SIP PROXY FIREWALL
40a
H.323 GATEKEEPER/FIREWALL
IPSEC AUTHENTICATION/ENCRYPTION
44

FIG. 10

MULTIPLE SUBSCRIBER VIDEOCONFERENCING SYSTEM

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of pending U.S. patent application Ser. No. 11/236,121 entitled "Multiple Subscriber Videoconferencing System" and filed Sep. 26, 2005. which is a continuation of U.S. patent application Ser. No. 09/819,548 entitled "Multiple Subscriber Videoconferencing System" filed Mar. 26, 2001 and issued as U.S. Pat. No. 6,980,526 B2 on Dec. 27, 2005. which claims priority under 35 U.S.C. §119(e) to U.S. Provisional Patent Application No. 60/191,819 entitled "System and Method for Security and Management of Streaming Data Communications on a Computer Network System," filed Mar. 24, 2000. the disclosures disclosure of which are hereby is herein incorporated by reference herein.

TECHNICAL FIELD

The present invention relates generally to videoconferencing, and more particularly to a system, method, and device for implementing a multiple subscriber videoconferencing service for use on Internet Protocol (IP) networks.

BACKGROUND OF THE INVENTION

Videoconferencing provides a convenient way for users in distant locations to participate in a face-to-face meeting, without having to spend time and money traveling to a central meeting site. Many prior videoconferencing systems have been based on circuit-switched Integrated Services Digital Networks (ISDN) standards. ISDN lines typically offer guaranteed quality of service, with specialized lines having high transmission rates. This enables high-quality video and audio signals to be delivered to the conferencing participants. However, ISDN videoconferencing is extremely expensive, because ISDN lines are costly to install and lease, and because specialized hardware is required at the sites of the users. Because of this expense, ISDN videoconferencing systems are typically offered in a specialized videoconferencing room, rather than at each desktop computer of each employee in an enterprise. In addition, ISDN can be complicated to set up, and unreliable. ISDN calls on average take more than 10 minutes to set-up, and greater than 10% of calls are dropped without being completed.

Recently, another approach to videoconferencing has emerged for use on packet-switched Internet Protocol (IP) networks, using the H.323 and Session Initiation Protocol (SIP) standards. H.323 is a standard approved by the International Telecommunication Union (ITU) in 1996 to promote compatibility in videoconference transmissions over IP networks. SIP is a proposed Internet Engineering Task Force (IETF) standard for multimedia communication over IP networks.

Videoconferencing over IP networks has a number of fundamental problems, including security, bandwidth utilization, quality of service, and deployment and management. Regarding security, H.323 and SIP are difficult to implement with current firewalls. The difficulty lies in the fact that H.323 and SIP are complex protocols and use multiple dynamically allocated ports for each call. Because of the heavy use of dynamically allocated ports, it is not possible to preconfigure firewalls to allow SIP- or H.323-signaled traffic without opening up large numbers of holes in the firewall. This represents a more lax firewall policy than would be acceptable at most enterprises. In addition, SIP or H.323 video endpoints behind a firewall typically cannot receive calls from external parties due to firewall policies in place at most enterprises.

Many enterprises also deploy Network Address Translation (NAT) devices, often implemented as part of a firewall application, to connect the enterprise network having private IP unregistered addresses to a public IP network with globally unique registered addresses. NAT is generally used for two purposes: 1) as a mechanism to work around the problem of IPv4 address space depletion, and 2) for security purposes (to hide internal IP addressing policy from outside entities. A NAT device rewrites IP headers as packets pass through the device. The NAT device maintains a table of mappings between IP addresses and port numbers. The problem with sending H.323 and SIP traffic through a NAT device is that these protocols make heavy use of embedded IP addresses, while normal data traffic contain IP address in the header of each packet. While configuring a NAT to rewrite packet headers to change addresses is relatively straightforward, it is very difficult to configure a NAT to translate addresses that are embedded in H.323 and SIP traffic, because the location of these address in these data stream is difficult to calculate.

Regarding bandwidth utilization, in order to achieve a quality sufficient for business videoconferencing, a minimum of 384 Kbps bandwidth is generally required per videoconferencing participant. Multiple users simultaneously engaged in videoconferencing applications may use up available bandwidth on a local area network (LAN), slowing down other critical network operations. Current systems do not allow a network administrator to control easily the bandwidth usage of multiple network users. Therefore, network administrators are reluctant to deploy videoconferencing systems.

Regarding quality of service, typical IP networks do not provide guaranteed transmission speeds for videoconferencing data. Videoconferencing data generally is indistinguishable from other data on IP networks, such as email and web page data. Data on IP networks may be delayed due to network congestion. While small delays are generally not a problem for less time sensitive data such as email, it can severely affect picture and audio quality for videoconference participants.

The above discussed issues lead to another problem with current videoconferencing systems, namely, that enterprises cannot easily outsource videoconferencing services to outside service providers. Currently, service providers are not able to cost-effectively provide videoconferencing services to a large number of subscribers, because specialized equipment must be deployed or existing equipment must be upgraded at every subscriber site. This results in an expensive up-front capital investment as well as significant operational expenses for the service provider. Up-front equipment installations take time at each subscriber, resulting in a slow deployment of the videoconferencing capabilities to subscribers. In addition, the high up-front costs result in decreased service provider profit margins. It is difficult to grow such a service because each subscriber adds to an incremental growth in the capital equipment pool because these resources are not shared.

Because of the cost and reliability issues with ISDN, and because of the security, bandwidth utilization, quality of service, and deployment and management issues with H.323 and SIP, it is difficult for the average enterprise to upgrade and customize its network to enable videoconferencing. In addition, it is difficult for service providers to cost-effectively provide an outsourced videoconferencing service on a per-subscriber basis. Thus there exists a need for a videoconferencing system, method, and device for delivering secure, high-quality videoconferencing services over an IP network to multiple enterprise subscribers in a manner that does not require expensive upgrading and customization of the enterprise network.

SUMMARY OF THE INVENTION

A system, method, and device for use in videoconferencing are provided. The method typically includes installing a videoconferencing switch at an access point to an IP network, and registering a plurality of subscribers for videoconferencing services. Each subscriber typically has a plurality of endpoints. The method further includes receiving subscriber-specific settings to be applied to multiple videoconferencing calls from the plurality of endpoints associated with each subscriber. The method further includes storing the subscriber-specific settings at a location accessible to the switch, and configuring the switch to connect calls from the plurality of endpoints at each subscriber based on the corresponding subscriber-specific settings.

According to another embodiment of the invention, the method may include installing a video services switch on a service provider network at an access point configured to enable multiple enterprise subscribers to access a global packet-switched computer network to exchange data, including videoconferencing data and non-videoconferencing data. The video services switch is typically configured to process videoconferencing data from multiple enterprise subscribers. The method further includes, at the video services switch, receiving a request for a videoconferencing call from an origination endpoint of one of the multiple enterprise subscribers, and connecting the videoconferencing call to a destination endpoint, the videoconferencing call having associated videoconferencing data. The method may further include securing the videoconferencing call based on subscriber-specific security settings.

The device typically includes a control plane module configured to receive subscriber-specific videoconferencing call settings for each of a plurality of video services subscribers, the videoconferencing call settings being for multiple calls placed from each video services subscriber, and a data plane module configured to receive videoconferencing data streams from multiple subscribers and manage these videoconferencing data streams according to the subscriber-specific videoconferencing call settings for each subscriber.

The system typically includes a service provider network configured to enable users of multiple enterprise subscriber networks to transfer data via a global computer network, the service provider network having an access point. The system also includes a videoconferencing services switch located on the access point of the service provider network. The videoconferencing services switch is configured to process videoconferencing calls from terminals on each of the multiple subscriber networks, based on subscriber-specific settings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic view of a videoconferencing system according to one embodiment of the present invention.

FIG. **2** is a schematic view of a videoconferencing system according to another embodiment of the present invention.

FIG. **3** is a schematic representation of a hardware configuration of a videoconferencing switch of FIG. **1**.

FIG. **4**A is a software architecture of the videoconferencing system of FIG. **1**.

FIG. **4**B is a continuation of the software architecture of FIG. **4**A.

FIG. **5** is a flowchart of a videoconferencing method according to one embodiment of the present invention.

FIG. **6** is a flowchart of one exemplary method for accomplishing the step of configuring the switch of the method of FIG. **5**.

FIG. **7** is a flowchart of one exemplary method for accomplishing the step of configuring the security module of the method of FIG. **6**.

FIG. **8** is a flowchart of one exemplary method for accomplishing the step of configuring the quality of service module of the method of FIG. **6**.

FIG. **9** is a flowchart of one exemplary method for accomplishing the step of configuring the user-specific and subscriber-specific settings of the method of FIG. **6**.

FIG. **10** is a schematic view of an enterprise video gateway of FIG. **1**.

DETAILED DESCRIPTION OF THE INVENTION

Referring initially to FIG. **1**, a videoconferencing system according to one embodiment of the present invention is shown generally at **10**. System **10** typically includes a videoconferencing services switch (VSS) **12** positioned on a service provider network **14** at an access point **16**, typically a point of presence (POP). Switch **12** is configured to register multiple enterprise subscriber networks **18** for videoconferencing services, receive subscriber-specific settings for each subscriber **18** related to security and management of the videoconferencing calls from that subscriber, and process videoconferencing calls from each subscriber based on the associated subscriber-specific settings.

Service provider network **14** typically includes a packet-switched Internet Protocol (IP) network through which multiple enterprise subscriber networks **18** may access a global IP network **20**, such as the Internet **20**. Typically, the service provider network **14** includes an access point **16**, such as a POP **16**. The POP has a unique IP address and/or dial-up telephone number that a device on the enterprise subscriber network **18** may contact to access network **20**.

POP **16** typically includes an edge router **20** and a core router **22** configured to route IP traffic into and out of POP **16**. POP **16** also includes a plurality of services switches **24**, including videoconferencing services switch **12**, described above, Voice Over Internet Protocol (VOIP) services switch **26**, and Virtual Private Network (VPN) services switch **28**. Upon instruction, edge router **20** is configured to route traffic coming into POP **16** to an appropriate services switch for service-specific processing, or to core router **22** via direct link **30**. Core router **22**, in turn, is configured to route traffic from either of the services switches **24**, or from direct link **30** out to the Internet **20**. The traffic may be routed across a metropolitan area or long-haul backbone, which may be leased or owned by the service provider.

Traffic coming into the POP can be classified into videoconferencing data and non-videoconferencing data. Videoconferencing data typically includes control data and streaming voice and audio data according to the H.323 or SIP standards. H.323 refers to International Telecommunications Union, Telecommunications Sector, Recommendation H.323 (version 1. published November 1996; version 2. published 1998. entitled, “Visual Telephone Systems and Equipment for Local Area Networks Which Provide a Non-guaranteed Quality of Service,” the disclosures of which are herein incorporated herein by reference. SIP refers to Session Initiation Protocol Proposed Standard (RFC 2543), Internet Engineering Task Force (IETF) (published March 1999), the disclosure of which is incorporated herein by reference. Non-videoconferencing data includes, for example, email, web pages, VOIP traffic, VPN traffic, etc. Videoconferencing data is typically routed through POP **16** via videoconferencing services switch **12**, while non-videoconferencing data is routed around the switch.

Each of enterprise subscriber networks **18** typically includes a plurality of terminals **34**. Terminals **34**, along with video conferencing service switch **12** and the various other components of system **10**, are typically H.323 or SIP compliant. Terminals **34** are typically videoconferencing devices configured to display and record both video and audio. Terminals **34** may be desktop computers, laptop computers, mainframes and/or workstation computers, or other videoconferencing devices. Terminals **34** may also be described as "endpoints" in a videoconferencing call. The terminal **34***a* originating the videoconferencing call is referred to as an origination endpoint **34***a*. and the other terminals requested to join in the call are referred to as destination terminals, shown at **34***b*. **134***a*. **134***b*. Terminal **34***b* is a local zone destination terminal, while terminals **134***a*. **134***b* are remote zone destination terminals. Local and remote zones are defined below.

Each enterprise subscriber network **18** also typically includes an enterprise video gateway **36** and enterprise edge router **38**. Enterprise edge router **38** is configured to route data traffic between terminals **34** and service provider network **14**, based on source and destination IP addresses.

Enterprise video gateway **36** typically includes an emulation module **40** which emulates H.323/SIP call control and firewall functionality and an encryption module **44**. The gateway also typically has a globally routable IP address and is configured to manage secure communication between terminals **34** and the videoconferencing services switch **12**. Typically, emulation module **40** appears to terminals **34** as H.323 gatekeeper/SIP proxy and H.323/SIP application proxy firewall which includes network address translation (NAT) capability, which hides internal addresses from outside devices.

As shown in FIG. **10**, enterprise video gateway **36** includes an encryption module **44**. Encryption module **44** is typically an IP Security (IPSec) authentication and encryption module **44** configured to encrypt videoconferencing data coming from terminals **34** and send the encrypted data to videoconferencing switch **12**. The IPSec protocols have been adopted by the Internet Engineering Task Force, and are described in the RFC 2411 entitled "IP Security Document Roadmap" (published November 1998), the disclosure of which is herein incorporated by reference. By using IPSec, a Virtual Private Network (VPN) may be created between the gateway **36** and the switch **12**. VPN refers to a network that is carried over public networks, but which is encrypted to make it secure from outside access and interference.

Videoconferencing data may be carried from terminal **34** to service provider network **14** via one of two routes. First, the videoconferencing data may be routed by edge router **38** via a direct network connection **42**, such as a T1 connection, to the videoconferencing services switch **12** of the service provider network **14**. In this case, the direct network connection is dedicated to video traffic. Second, firewall **40** may be configured to pass encrypted videoconferencing data through the firewall unexamined. Typically, the encrypted videoconferencing data is encrypted by the encryption module **44** of the enterprise video gateway **36** using the IPSec protocols, discussed above.

System **10** is divided into local metropolitan zone **11** and remote metropolitan zone **111** separated by backbone **32**. Local metropolitan zone **11** includes all devices that connect to POP **16**, and remote metropolitan zone **111** includes all devices that connect to POP **116**. Components within remote metropolitan zone **111** are similar to those in local metropolitan zone **11** and are numbered correspondingly, and therefore will not be redescribed in detail.

System **10** may be configured to connect a two-party or multiparty videoconference call from an origination terminal **34***a* to a destination terminal **34***b* on local zone **11**, and/or one or more destination terminals **134***a* and **134***b* on remote zone **111**. A destination terminal on local zone **11** may be referred to as a local destination terminal, and a destination terminal on remote zone **111** may be referred to as a remote destination terminal.

FIG. **2** shows another embodiment of a videoconferencing system **210** having a local zone **211**. It will be appreciated that a remote zone of system **210** is a mirror image of zone **211**, similar to that described above for system **10**. Local zone **211** includes multiple enterprise subscriber networks **218** linked to a Digital Subscriber Line (DSL) service provider network **214** via an access point **216**, typically called a central office.

Each enterprise subscriber network **218** includes a plurality of terminals **234** which are similar to terminals **34** described above. Integrated Access Device (IAD) **246** is configured to receive traffic from enterprise subscriber networks **218** and forward the traffic to the Digital Subscriber Line Access Multiplexor (DSLAM) **248**. The DSLAM is configured to multiplex the traffic from the IADs and forward it to Asynchronous Transmission Mode (ATM) switch **250**, where the signals are demultiplexed for transmission over a long-haul backbone. ATM switch **250** is configured to route videoconferencing data to and from terminals **234** and the backbone via videoconferencing services switch **212**, and non-videoconferencing data via ISP router **252**, or another services switch.

FIG. **3** shows an exemplary hardware configuration for videoconferencing services switch **12**. One switch that may be purchased and programmed to implement the present invention is the Intel Exchange Architecture (IXA) WAN/Access switch, commercially available from Intel Corporation, of Santa Clara, Calif. and Radisys Corporation of Hillsboro, Oreg.

Switch **12** typically includes a control plane module **302** and a data plane module **304**. Control plane module **302** includes a host processor, linked to an input/output network interface **308** and a memory **310**. Typically, memory **310** includes RAM and ROM, although another form of memory may also be used, such as flash memory. Alternatively, a storage device such as a hard drive may also be attached to host processor **306**. Control plane module **302** is configured to receive control data such as call set-up information through network interface **308**, data plane ingress port **318**, or data plane egress port **320**. The call set-up information is processed according to H.323 or SIP specifications by host processor **306**. Typically, the programs and data necessary for processing the call are stored in memory **310** and implemented by host processor **306**. For example, the virtual router, call control module, quality of service module, policy engine, and security module are typically stored in memory **310**.

Control plane module **302** is linked to data plane module **304** via a bus **312**. Data plane module **304** includes a network processor **314** and memory configured to receive and manage transfer of real-time audio and video data streams from ingress ports **318** to egress ports **320**. Data plane module **304** typically includes a wire-speed switching fabric, capable of processing real-time data streams with virtually no appreciable latency.

The wire-speed switching fabric is configured to enable transport of streaming data traffic across system with virtually no appreciable latency, even as the streaming data traffic is processed and analyzed by system **10** to impose H.323/NAT-specific firewall and NAT capabilities, policies from policy engine **418**, monitor quality of service, and provide optional encryption and other security measures. One implementation of system **10** is configured to provide aggregate streaming data throughput of up to 1.048 Gbps with full security and policy management, quality of service management, and encryption. The wire-speed switching fabric includes full support for IETF standard IP routing protocols such as Open Shortest Path First (OSPF), Border Gateway Protocol (BGP), and Routing Information Protocol (RIP), which are well known in the networking arts. Support of these routing protocols will allow system **10** to forward video traffic appropriately to edge router **20** and core router **22** in the service provider access point **116**.

FIG. **4** shows a schematic view of the software components of videoconferencing system **10**. Enterprise network **18** typically includes terminal **34** having terminal settings **408***a*, enterprise video gateway **36** having gateway settings **408***o*. and an enterprise edge router/IAD **38**, **248** having enterprise router settings **408***b*. Settings **408***a*. **408***o*. and **408***b* are referred to as enterprise network resident settings, while the remaining settings **408***c*-**408***n*. **408***p* are referred to as switch resident settings.

Terminal settings **408***a* typically include the IP address of the enterprise gateway, which acts as a proxy to the call control module **413** in videoconferencing switch **12**. For calls placed with the H.323 protocol, the IP address of the enterprise gateway **36** (which also acts as a proxy to the videoconferencing services switch H.323 gatekeeper **414**) is provided. For calls placed with the SIP protocol, the IP address of the enterprise gateway **36** (which also acts as a proxy to the videoconferencing services switch SIP proxy **416**) is provided. Terminals use the IP address of the enterprise gateway for registration (using e.g. H.323 RAS signaling), call initiation (using e.g. H.323 ARQ signaling), and audio/video data exchange (using e.g. RTP/RTCP protocols). Users may optionally authenticate themselves with H.323 gatekeeper/SIP proxy. The enterprise gateway **36** encapsulates these messages in packets having the enterprise video gateway's globally routable IP address as the source address and forwards these messages to the call control module **413** in videoconferencing services switch **12**. Typically, these packets are sent in an encrypted form using IPSec.

Enterprise video gateway settings **408***o* include secure communication channel settings. Typically, this includes instructions on how to create a secure communication channel between the enterprise gateway and the videoconferencing switch **12** according to the IPSec protocol, discussed above. Traffic sent using the IPSec protocol typically passes through firewall **40** unexamined. Adjusting settings **408***o* of the enterprise video gateway to enable IPSec authentication and encrypted data exchange with the video services switch may either be accomplished locally by the enterprise administrator or service provider personnel via subscriber network management application **410**, or remotely via the video conferencing services management application **402**.

Enterprise edge router settings **408***b* typically include the globally routable IP address of the enterprise gateway **36**, and the address of an H.323 gatekeeper **414** and/or SIP proxy **416** within the videoconferencing services switch **12**. The enterprise edge router may also be configured to direct traffic from a terminal to the gatekeeper **414** or proxy **416** along direct connection **42**. Enterprise edge router settings **408***b* may also include prioritization information for traffic passing though the edge router, such that the router may tag packets passing through with Diff-Sery labels or process packets based on Diff-Sery labels.

For DSL service provider network **112**, shown in FIG. **2**, terminal settings **408***a* are configured with the IP address of the call control module **413**, as discussed above. IAD settings **408***b* are set to create a separate ATM permanent virtual circuit (PVC) or Frame Relay (FR) Data Link Communication Identifier (DLCI) for video traffic destined for the videoconferencing services switch. Optionally, the settings **408***b* may include priority settings for processing and delivery of video PVC/DLCI traffic.

Switch **12** typically includes a tunneling service module **411** having subscriber-specific settings **408***q*. The tunneling service module is configured to support secure communication channels from a multiple enterprise video gateways **36**, using the IPSec protocol described above. The tunneling service module unencapsulates traffic from enterprise video gateways **36**. It also maintains a dynamic mapping of IP address of each enterprise video gateway and port numbers so that the enterprise video gateway can correctly route call setup and video traffic back through to the appropriate enterprise video gateway.

Switch **12** typically includes a virtual router **412** configured to route requests from terminal **12** to call control module **413**. Typically, at least one virtual router having a unique IP address is provided for each subscriber network **18**. Traffic is routed between call control module **413** and enterprise video gateway/IAD **36**, **246** based on settings **408***c*. The virtual router settings **408***c* typically include the address of enterprise edge router **38** or IAD **246**, information about the dedicated physical connection **42**, and or the POP edge router **20**. Typically, a separate virtual router is provided for each enterprise subscriber. To configure the routing services, the switch provides BGP and OSPF routing on a per-virtual router basis. Thus, separate routing tables are maintained for each subscriber to segment its traffic.

Calls in the H.323 protocol are routed to virtual H.323 gatekeeper **414**, while calls in the SIP protocol are routed to SIP Proxy **416**. Call control module **413** is configured to perform call set-up operations, manage call data streams, and perform call tear-down operations.

Switch **12** also includes a policy engine **418** configured to enforce policies based on subscriber-specific settings on the videoconferencing calls. The policies may be based on subscriber-wide settings **408***f* that apply to all calls from a given subscriber, and user-specific settings that apply to only a single user or terminal of a given subscriber. Exemplary policies include outbound/inbound calling privileges, encryption policies, bandwidth policies, priority among users policies, participation privileges, inbound/outbound calling restrictions, time-of-day restrictions, audio or video restrictions. Each of these exemplary policies may be implemented on a per-user or per-subscriber basis. For example, a particular user may be able to use unlimited bandwidth, have a top priority among users, be allowed to both view and participate in calls, be able to both initiate outbound and receive inbound calls, from 8 am-6 pm Mon-Fri, and not be restricted to only audio or only video calling.

Switch **12** also includes a quality of service module **420** having a Multi Protocol Label Switching (MPLS) traffic engineering module **422** configured to create a network path engineered according to the MPLS standard. The MPLS architecture is described in the January **2001** Request For Comments entitled "Multiprotocol Label Switching Architecture," published by the Internet Engineering Task Force, the disclosure of which is herein incorporated by reference. Module **422** is configured to create secure MPLS tunnels that offer a guaranteed bandwidth for video traffic, based on subscriber-specific settings **408***h*. Settings **408***h* may include the desired bandwidth a subscriber has purchased, or the type of security to be applied to the MPLS traffic, etc.

Quality of service module **420** also includes a bandwidth management module **424** configured to manage the bandwidth allocated to each videoconferencing call and/or call participant. By managing the bandwidth based on subscriber-specific bandwidth settings **408***i*, network congestion can be avoided.

Quality of service module **420** also includes a differentiated services module **426** configured to implement differentiated services policy management according to the Differentiated Services standard described in the Definition of Differentiated Services Per Domain Behavior and Rules for their Specification, published by the Internet Engineering Task Force (January 2001), the disclosure of which is herein incorporated by reference. This typically includes labeling a precedence parameter for video traffic, i.e. RTP streams, stored in settings **408***j*.

Quality of service module **420** also includes an IP-over-ATM module **428** configured to send IP traffic over ATM switches, and settings **408***k* therefor. IP-over-ATM module **428** is compliant with the standards described in Internet Engineering Task Force Request for Comments (RFC) 2684. Typically, settings **408***k* for IP-over-ATM module **428** are configured on a per-virtual router and per-physical interface basis.

Quality of service module **420** also includes a video transmission analysis engine **430** configured to analyze videoconferencing data carried by the switch for quality parameters specified in transmission analysis settings **408***m*. Exemplary quality parameters include packet loss, jitter, and latency.

Videoconferencing services switch **12** also typically includes a security module **431**. Security module **431** typically includes a SIP/H.323 firewall **432**, SIP/H.323 NAT module **434**, encryption module **436**, and Virtual Private Network (VPN) module **438**. SIP/H.323 firewall **432** is configured to prevent unauthorized access to video services switch **402**, and through it to subscriber networks. The firewall settings **408***n* of firewall **432** are configured on a per-subscriber basis, such that a subscriber-specific firewall may be custom-implemented for traffic from each subscriber. SIP/H.323 NAT module **434** is configured to provide network address translation services for traffic flowing through switch **12**. NAT settings **408***l* are also subscriber-specific. VPN module **438** is configured to create a virtual private network for data flowing from switch **12** over network **20**.

System **10** typically includes a videoconferencing services management application **402** configured to enable the service provider to adjust the switch-resident settings of videoconferencing services switch **12** and settings **408***o* of enterprise video gateway **36**, **236**. System **10** also includes a subscriber network management application **410**, by which an administrator may adjust settings of devices on subscriber network **18**, such as settings **408***a* on terminal **34**, **134**, **408***b* on enterprise router/IAD **38**, **246**. Typically, subscriber network administrator uses subscriber network management application **410** to adjust the settings of each terminal when the terminal is installed or reconfigured. Alternatively, terminal settings **410***a* may be set remotely by the service provider via videoconferencing services management application **402**.

Videoconferencing services management application **402** is configured to interface with a database **404**, which contains a database image **406** of records for subscriber-specific settings **408** for each of the multiple enterprise subscriber networks **18**. Many of the subscriber-specific settings **408** are governed by a Service Level Agreement (SLA) **409**. The SLA is an agreement executed between each enterprise subscriber and the service provider. The SLA contains terms for the level of videoconferencing service to be provided to a particular enterprise subscriber network. One exemplary term contained in the SLA is a video quality term, which indicates the maximum and/or minimum video quality the subscriber is to receive, either on a per-subscriber, per-user, or per-terminal basis. Often, video quality is defined as packet loss, jitter, and latency being within an acceptable predetermined range. While, typically, terminal settings **408***a* and enterprise router settings **408***b* are stored locally on enterprise subscriber network **18**, it will also be appreciated that they may be stored on database **404**. The switch resident settings are typically loaded into video services switch **12** periodically, such as once per day, by downloading database image **404** into memory of switch **12**. The enterprise video gateway server settings **408***r* may be downloaded in a similar manner from database **404** via videoconferencing services management application **402**.

In FIG. **5**, a method according to one embodiment of the invention is shown generally at **500**. Method **500** typically includes, at **502**, installing a videoconferencing services switch (VSS) **12** at an access point **16** to an Internet Protocol (IP) network **20**. At **504**, the method typically includes switch **12** registering multiple enterprise subscriber networks **18** for IP videoconferencing services.

At **506**, the method includes receiving subscriber-specific settings **408** to be applied to multiple videoconferencing calls originating from the subscriber. The subscriber-specific settings may be set and accessed by an administrator at an enterprise network and/or an administrator at service provider (SP) network **14** via management applications **402**, **410**, described above. At **508**, the method further includes storing subscriber-specific settings at a location accessible to switch **12**. Typically, the subscriber-specific settings are stored on switch **12** and enterprise video gateway **36**, and in database **404**. Certain subscriber-specific settings **408** may also be stored on terminal **34** and enterprise router **38**, as described above.

At **510**, method **500** includes configuring switch **12** to connect videoconferencing calls between subscribers based on corresponding subscriber-specific settings. Step **510** is typically accomplished via steps **602**-**620**, described below.

At **512**, the method further includes receiving and processing a videoconferencing call at switch **12**. Typically, a user at a terminal **34** at enterprise subscriber network **18** initiates a call connection request for a videoconferencing call with a user at a destination terminal, such as remote destination terminals **134***a*. **134***b* or local destination terminal **34***b*. The call connection request typically includes pertinent information such as the origination and destination party address.

Step **512** is typically accomplished by, at **514**, receiving the call connection request at switch **12** and proceeding to connect the requested call by using the H.323 or the Session Initiation Protocol (SIP) protocol at **516**. The protocol used is determined by the subscriber-specific settings, or by the call request itself

Once the call connection request is processed and videoconferencing is occurring, at **518**, the method includes monitoring the established videoconferencing call. Switch **12** may monitor or record call information related to videoconferencing such as quality, duration of call, etc.

Typically, when the user wishes to end the videoconferencing call, the user will send a call termination request. The method includes receiving the call termination request at **520**.

The method further includes logging the videoconferencing call information in a call record at **522**. The call record may serve to provide billing information to SP **14** and to obtain data for quality assurance purposes. The call record may include length of call, parties on the call, bandwidth used by the call, measured quality of the call (as determined for example by jitter, latency, and packet loss), among other parameters.

Referring to FIG. **6**, configuring switch **12**, at **510**, to connect videoconferencing calls includes configuring various components and modules as shown. At **602**, step **510** includes configuring a tunneling module, which includes at **604**, creating an IPSec tunnel between switch **12** and gateway **36**. This step requires setting up IPSec authentication and encryption parameters on switch **12**, as described. The tunneling module unencapsulates traffic from gateway **36** and maintains a dynamic mapping of IP address of servers **36** and port numbers, thus allowing gateway **36** to route call set-up correctly and video traffic back through the appropriate gateway **36**.

Step **510** includes, at **606**, configuring a virtual router (VR) **412**, which includes, at **608**, creating VR **412** within switch **12** for subscriber **18**. Typically a subscriber edge router **20** is mapped onto switch **12**. VR **412** is integral to module segmentation and layering architecture of switch **12**.

Step **606** further includes, at **610**, configuring routing services for subscriber **18**, which includes the support of BGP and OSPF routing using VR **412**. Typically routing tables are maintained for subscriber **18** to segment traffic.

Step **510** includes, at **612**, configuring a call-control module. At **614**, step **612** includes configuring H.323 gatekeeper **414** and/or SIP proxy **416** for subscriber **18**. For H.323 gatekeeper **414**, configuring gatekeeper **414** includes configuring a subscriber zone in gatekeeper **414**, discovery and registration of endpoints, security, inter-gatekeeper communication, creation of records for billing and administrative purposes, etc. For SIP proxy **416**, configuring proxy **416** includes discovery and registration of endpoints, information from Domain Name Service (DNS) server, creation of records, etc.

Step **510** further includes configuring security module at **616**, configuring quality of service module at **618**, and configuring user-specific and subscriber-specific settings on a policy engine **418** at **620**.

Referring to FIG. **7**, step **616** includes configuring H.323/SIP firewall **432** at **702**. H.323/SIP applications parse control data to dynamically open and close ports for control traffic. Information obtained from parsing is sent to network data plane hardware **304**. Configuring firewall **432** includes adding firewall address information into gatekeeper **414** for the zone, setting ports or channels that are statically open, and setting security logging.

Step **616** further includes configuring H.323/SIP network address translation (NAT) module at **704**. For H.323 NAT module, the NAT module is configured to parse packet headers and payload of Q.931/H.245 control data streams during call set-up. For outgoing data, the NAT module is further configured to substitute non-routable endpoint source IP addresses and port numbers with its own globally unique H.323 proxy IP address and port numbers. For incoming data, the NAT substitutes non-routable, or internal endpoint destination IP addresses and port numbers by using stored IP address/port number mapping information.

Step **616** further includes configuring the encryption module at **706**. Encryption is used only at certain enterprise subscribers **18** and destination IP addresses. For example, enterprises **18** may want encrypted communication with selected destination parties.

Lastly, step **616** includes configuring virtual private network (VPN) module at **708**. Configuring VPN module includes configuring a subscriber VR with MPLS VPN capability including creation of VPN routing/forwarding tables. Step **708** further includes configuring BGP routing sessions, VR to SP edge-routing sessions, RIP/BGP/static route to subscriber edge-routing sessions, etc. By configuring switch **12** to support an MPLS VPN module, video-specific VPNs can exist across ATM, IP and L2-type backbone networks. In addition, subscribers to MPLS VPNs may be dynamically updated to enable simplified creation of extranet and intranet VPNs and site-to-site video traffic delivery.

Referring to FIG. **8**, step **618** of configuring quality of service module includes configuring an MPLS traffic engineering (TE) module at **802**. Configuring switch **12** to support MPLS TE enables creation of premium-priced guaranteed bandwidth videoconferencing data paths across an SP MPLS backbone. Step **802** further includes configuring of MPLS tunnels, enabling of express forwarding of data, and enabling Intermediate System-Intermediate System (IS-IS) routing, as is commercially implemented in the products of Cisco Systems of San Jose, Calif. This is typically accomplished by adjusting settings **408***h*.

At **804**, the method further includes configuring bandwidth management module **422**, typically by adjusting settings **408***i*. This enables setting of maximum video bandwidth allowed into or from an enterprise subscriber by time of day.

At **806**, the method further includes configuring differentiated services (Diff-Serv) module **426** at **806**, typically by adjusting Diff Sery settings **408***j*. These settings may be used to configure the TOS/IP precedence field for video traffic (i.e. RTP streams) to/from each enterprise. This enables core devices in an SP network to give prioritized treatment to video traffic.

At **808**, the method further includes configuring IP over asynchronous transfer mode (ATM) module, typically by adjusting settings **408***k*. IP over ATM services are configured on a per-virtual router and per-physical interface basis.

At **810**, the method further includes configuring video transmission analysis module, typically by adjusting settings **408***m*. Configuration of size of jitter buffer within the videoconferencing services switch is accomplished on a per-enterprise subscriber basis.

FIG. **9** shows, in steps **902-918**, one exemplary method of accomplishing step **620** of configuring user-specific and subscriber-specific policies on policy engine **418**. The method

Page **23** typically includes, at **902**, setting access privileges. Access privileges govern who can access the video system with user level and administrator level access privileges. At **904**, the method includes setting inbound/outbound calling privileges on a per-user or per-subscriber basis. For example, every user in an enterprise may be prohibited from making outbound calls on company holidays, except upper management. At **906**, the method typically includes setting time-of-day privileges per user or subscriber. For example, every user may be restricted from placing calls outside of regular business hours. At **908**, the method typically includes setting maximum video quality privileges per user, or per subscriber.

At **910**, the method typically includes setting **2**-way support privileges. This allows a user to either send, receive, or both send and receive videoconferencing data pertaining to a call. At **912**, the method includes setting audio-only restrictions on a per-user or per-subscriber basis. The method includes setting encryption requirements at **914**. At **916**, the method typically includes setting priority privileges on a per-user or per-subscriber basis. Videoconferencing data sent by a user with higher priority privilege will take precedence over other data sent by a user of lower priority, or over other lower priority data, such as email. At **918**, the method typically includes setting videoconferencing call screening. This enables a user or subscriber to block incoming calls from a user-specified source. The policies set in step **620**, and sub-steps **902-918** are typically saved as user-specific and subscriber-wide settings **408***f*, **408***g*.

While the present invention has been particularly shown and described with reference to the foregoing preferred embodiments, those skilled in the art will understand that many variations may be made therein without departing from the spirit and scope of the invention as defined in the following claims. The description of the invention should be understood to include all novel and non-obvious combinations of elements described herein, and claims may be presented in this or a later application to any novel and non-obvious combination of these elements. Where the claims recite "a" or "a first" element or the equivalent thereof, such claims should be understood to include incorporation of one or more such elements, neither requiring nor excluding two or more such elements.

We claim:

1. A system, comprising:
- videoconferencing services switches adapted for deployment across a service provider Internet Protocol (IP) network, each videoconferencing services switch adapted to be linked to at least one other videoconferencing services switch and comprising:
  - a call control module providing control of videoconferencing calls, the call control module configured to perform call set-up operations, to manage call data streams, and to perform call tear-down operations;
  - a security module configured to provide firewall services for videoconferencing calls, the security module further comprising:
    - a Session Initiation Protocol (SIP) firewall module configured to use firewall settings on a per-subscriber basis to allow a subscriber-specific firewall that is custom-implemented for traffic from each subscriber; and
  - a tunneling services module configured to provide a virtual private network (VPN) between the videoconferencing services switch and a subscriber IP network.

2. The system of claim **1**, further comprising:
- a virtual router that routes call data between one or more subscriber IP networks and the call control module, and that segments call data for each subscriber; and
- a virtual private network (VPN) module configured to create virtual private networks for traffic between two videoconferencing services switches.

3. The system of claim **1**, wherein the call control module further comprises:
- a Session Initiation Protocol (SIP) proxy module for controlling the videoconferencing calls placed with the SIP protocol.

4. The system of claim **1**, further comprising:
- a policy engine that enforces policies on the videoconferencing calls based on subscriber-specific settings.

5. The system of claim **4**, wherein the subscriber-specific settings comprise subscriber-wide settings that apply to all calls from a subscriber and user-specific settings that apply to a particular terminal of the subscriber.

6. The system of claim **4**, wherein the subscriber-specific settings are selected from the group consisting of:
- outbound/inbound calling privileges, encryption policies, bandwidth policies, priority among users' policies, participation privileges, inbound/outbound calling restrictions, time-of-day restrictions, audio or video restrictions.

7. The system of claim **4**, wherein the subscriber-specific settings include firewall settings.

8. The system of claim **4**, wherein the subscriber-specific settings include network address translation (NAT) settings.

9. The videoconferencing services switch of claim **1**, wherein the security module is further configured to provide network address translation services for videoconferencing calls, and wherein each videoconferencing services switch is adapted for deployment at an access point of the service provider IP network.

10. The system of claim **9**, wherein the videoconferencing services switches direct the videoconferencing calls from each of the participants to the closest service provider network access point.

11. A videoconferencing services switch adapted for deployment in a service provider Internet Protocol (IP) network and capable of processing a videoconferencing call between an origination terminal and a destination terminal, the origination and destination terminals being located on one or more subscriber IP networks, the videoconferencing services switch comprising:
- a call control module capable of performing call set-up and tear-down operations and managing call data streams for the videoconferencing call;
- a quality of service module capable of being configured to guarantee quality of service for the videoconferencing call placed via the switch according to the subscriber-specific settings;
- a security module configured to provide firewall services for the videoconferencing call, the security module further comprising a Session Initiation Protocol (SIP) firewall module configured to use firewall settings on a per-subscriber basis to allow a subscriber-specific firewall that is custom-implemented for traffic from each subscriber;
- a tunneling services module configured to provide a virtual private network (VPN) between the videoconferencing services switch and a subscriber IP network; and
- a policy engine capable of being configured to enforce policies on the videoconferencing call based on subscriber-specific or user-specific settings.

12. The videoconferencing services switch of claim **11**, wherein the subscriber-specific settings are selected from the group consisting of: calling privileges, encryption, bandwidth, priority, participation, and restriction policies.

13. The videoconferencing services switch of claim **11**, wherein the quality of service module comprises:
- a call bandwidth management module.

14. The videoconferencing services switch of claim **11**, wherein the quality of service module comprises:
- a call Multi-Protocol Label Switching (MPLS) traffic engineering module.

15. The videoconferencing services switch of claim **11**, wherein the quality of service module comprises:
- a call Differentiated Services (Diff Serv) capabilities module.

16. The videoconferencing services switch of claim **11**, wherein the security module further comprises:
- a Session Initiation Protocol (SIP) Network Address Translation (NAT) module configured to provide network address translation services for videoconferencing calls placed with the SIP protocol.

17. The videoconferencing services switch of claim **11**, wherein the security module is further configured to provide network address translation services for videoconferencing calls, and wherein each videoconferencing services switch is adapted for deployment at an access point of the service provider IP network.

18. A method for providing videoconferencing services using videoconferencing services switches adapted for deployment across a global Internet Protocol (IP) network, comprising:

receiving call control data and call set-up information from call origination and destination videoconferencing endpoints in subscriber IP networks;

receiving encrypted real-time audio and video data streams from the call origination and destination videoconferencing endpoints in subscriber IP networks;

managing transfer of the encrypted real-time audio and video data streams between the videoconferencing services switches and subscriber IP networks; and

enforcing policies on videoconferencing calls based on subscriber-specific settings, wherein the subscriber-specific settings comprise subscriber-wide settings that apply to all calls from a subscriber and user-specific settings that apply to a particular terminal of the subscriber.

19. The method of claim **18**, wherein the subscriber-specific settings are selected from the group consisting of: calling privileges, encryption, bandwidth, priority, participation, and audio/video restriction policies.

20. The method of claim **18**, wherein the subscriber-specific settings are globally configurable.

21. The method of claim **18**, wherein the subscriber-specific settings include firewall settings.

22. The method of claim **18**, wherein the subscriber-specific settings include NAT settings.

23. The method of claim **18**, wherein managing transfer of the real-time audio and video data streams further comprises:

managing call bandwidth.

24. The method of claim **18**, wherein each videoconferencing services switch maintains a repository of subscriber-specific settings.

25. The method of claim **18**, wherein the videoconferencing services switches are adapted for deployment at access points in a service provider IP network.

26. The method of claim **18**, further comprising:

routing the encrypted real-time audio and video data streams through network address translation (NAT) devices in the subscriber IP networks.

27. A system for use in videoconferencing, comprising:

videoconferencing services switches adapted for deployment across a global IP network, each videoconferencing services switch configured to provide control of videoconferencing calls from videoconferencing terminals in one or more subscriber IP networks, based on subscriber- specific settings; and to manage transfer of encrypted real-time audio and video data streams between the videoconferencing services switches and subscriber IP networks, wherein the subscriber-specific settings comprise subscriber-wide settings that apply to all calls from a subscriber and user-specific settings that apply to a particular terminal of the subscriber.

28. The system of claim **27**, wherein the videoconferencing service switches are adapted for deployment at service provider IP network access points to process the videoconferencing calls from terminals of each of the subscriber IP networks.

29. The system of claim **28**, wherein the videoconferencing services switches direct the videoconferencing calls from each of the participants to the closest service provider network access point.

30. The system of claim **27**, wherein the encrypted real-time audio and video data stream traffic is routed through network address translation (NAT) devices in the subscriber IP networks.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,154,734 B2
APPLICATION NO. : 13/865190
DATED : October 6, 2015
INVENTOR(S) : Saqib Jang et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In Column 14, at line 32, delete "the" (second occurrence).

Signed and Sealed this
Thirty-first Day of May, 2016

Michelle K. Lee

Michelle K. Lee
Director of the United States Patent and Trademark Office